

Recommendations for the Electrical Installation of IceCube

Howard Matis
Lawrence Berkeley National Laboratory

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As the present space in MAPO is insufficient to house the IceCube electronics, it will be necessary to provide a new building to house the IceCube electronics. This new facility provides an excellent opportunity to create an environment that is optimized for the electronics.

At my recent tour at the pole, I examined the electrical layout of the Amanda electronics. The general layout of the electronics was excellent. When IceCube is constructed, a number of improvements can be made that would improve the operation of the experiment. This memo will stress what can be changed on the Amanda design to make the electrical environment of IceCube much better.

Electrical Power Distribution

1. **All of the power in MAPO is powered by one transformer. There is possible electrical interference from the shop and other experiments.** There needs to be two types of power. Pumps and motors should run off dirty power. There needs to be a “clean” power distribution for the IceCube electronics. The best way to provide it is to use an isolation transformer. Only IceCube electronics should be on this transformer. Any other experiment in the building should have a separate transformer.
2. **200+ V power is not readily available.** Amanda obtains 220 V power ad hoc by transformers resting on the floor. Modern electronics can run from 110 to 240 V and between 50 and 60 Hz so it might not be necessary to implement this voltage. Some European equipment and high power electronics requires voltages larger than 120 V. First, IceCube needs to ascertain whether to support this higher voltage. If this voltage is required, then there needs to be a method to provide the capability of 200+ V where it is required. If needed, it is important for IceCube to select the appropriate transformer and then standardize on the specific 200+ V. (For example, a Delta-Wye transformer will generate 208 V off 480 V input). It is inconvenient to have a mixture of American and European power connectors. With a standard plug, then equipment can easily be moved from one rack to another.
3. **There is hodgepodge of extension cords supplying 120 V to the racks and the tables.** An adequate number of outlets must be provided to each rack and to all work surfaces. Racks need to have AC outlets on both the front and back of the crate.

Rack Space

1. **There is a problem with too much heat in the racks. Several household fans are necessary to keep the electronics running. This problem is aggravated by the high altitude of the pole location.** Cooling of the electronics must be provided. There are several ways to accomplish it from air cooling to water-cooling. First, there needs to be adequate space under the electronics and above the electronics. Careful design has to be done with the equipment placed inside the racks. Solutions include putting blowers between equipment and putting fans on top of the racks. Water-cooling is much more complicated and requires a separate system. A complete solution can only be done when the internal electronics is specified. However, it is essential to include some provision for cooling at the onset of design. Furthermore, there is a reliability problem with fans at the pole. All fans should be certified to work in the South Pole environment.
2. **Modern electronics chassis are very long.** The racks should be able to accommodate equipment up to 36" in depth.
3. **Interconnects between racks are difficult. There is little space for utilities in racks.** Experience has shown that having a small space between racks provides an excellent place to route utilities and cables. The space can be used for patch panels. It is possible to put this utility closet between every other racks. It is best to purchase racks that have built in space.
4. **Racks need to have provision to mount equipment on both sides.** This provision will provide more useable rack space.
5. **Heavy electronic chassis need to be supported.** Rails should be provided to facilitate the movement of equipment into and out of the racks.

Cable layout

1. **Careful attention must be made to routing the cables from the ice.** The method for routing these cables should minimize excess cable length and provide an easy way to connect the cables to the electronics. A patch panel for these cables should be included in the design. Providing an elevated floor so that cables can be easily routed should be considered.
2. **There are many dangling cables.** There needs to be overhead cable trays to facilitate running temporary cables. These trays should be to all work surfaces. Providing an elevated computer floor to allow room for cables underneath would make it easier to run cables.

Grounding

1. **There is no good ground at the pole.** We hear stories such as whenever the wind blows, there is an increased amount of electrical noise in Amanda. There are one or more additional sources of regular electrical bursts of noise in the electronics. Careful attention should be paid to how the building is grounded. The IceCube electronics must have a single point ground. Figure 1 shows a schematic for the grounding. It is very important that equipment that are powered by the three transformers NOT be in direct electrical contact. This contact should also minimize the capacitive coupling. Typically, the

capacitive coupling should be in the nanofarad range. This implies that electrical isolation must have substantial separations. Thin Mylar sheets cannot achieve this capacitance.

2. **Racks and workbenches need a good ground.** The present method of having one low inductance copper path connecting all equipment is excellent. Its design should be duplicated in IceCube. It is also important to make sure all racks are firmly attached to each other. This is not presently done in Amanda.

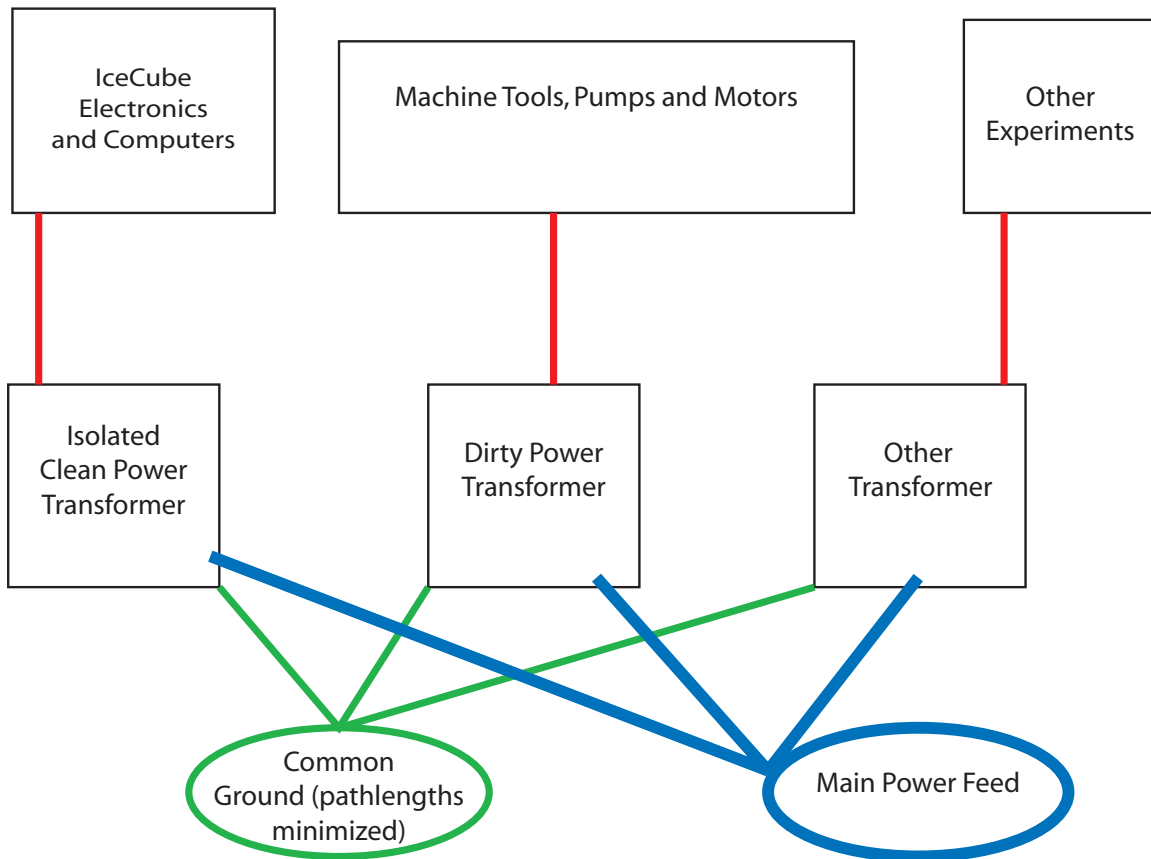


Figure 1- Schematic for grounding IceCube.

Implementation of Electrical Design

1. **The electrical design of IceCube is not fully designed.** For instance, the cooling of the racks cannot be designed until there is a detailed description of the electronics inside the racks. The number of racks has not been determined. At this time, it is not clear that all equipment will be in racks. Consequently, the experimental area at the Pole must be flexible enough to handle the final design. Furthermore, there needs to be space designated for computers.
2. **There needs to be a physicist from IceCube involved with the construction of the facility.** The contractor, working on the electrical installation, needs to be informed immediately of changes in the IceCube

design. The physicist needs to communicate to the contractor the priorities of IceCube and advise the contractor on the effect of the contractor's design decisions. An example of this need for such a close cooperation can be illustrated by the problem of cooling the electronics in the rack. Knowledge of the heat concentration in a rack is needed. This can only be done by an IceCube person. A decision on whether to cool the racks by water or use simple convection can only be made by looking at its effect cooling system and the knowledge of the space available in the new building. Consequently, the design for rack cooling can only be done properly with the close interaction of IceCube and the electrical contractor.

3. **The space for Amanda is overcrowded.** Only a few people can work in MAPO at the same time. There should be adequate room to install the electronics. There needs to be a significant area set-aside for installation of equipment. This includes the need for several electrical workbenches. If a laser is incorporated into the IceCube design, then a suitable enclosure must be built for it. The design for the building must anticipate future expansion of IceCube. Just as Amanda expanded, the space requirements for IceCube certainly will. There needs to be enough power, rackspace, cooling capacity, etc. for future expansion.